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13. ABSTRACT *(Maximum 200 Words)*

The ATNRC is entering the second year of its second four-year funding cycle. Its missions remain the following: Assessment and enhancement of cognitive and motor function; evaluation and support for Activities of Daily Living; applications of telehealth and Virtual Reality; and product design.

Accomplishments from year one of the new cycle included the development of a turnkey Virtual Reality testbed that incorporates gaze monitoring. Automated Neuropsychological Assessment Metrics (ANAM) was implemented in brain concussion studies of the 82nd Airborne at Ft. Bragg and the US Military Academy at West Point. These studies encompassed over 6,000 baseline assessments and demonstrated ANAM's capability as a population surveillance instrument for military and civilian health applications. Informatics software was developed for manipulating unprecedented quantities of ANAM information, and sharing that software with military and civilian ANAM users. These users' groups included NASA, several Veterans Administration hospitals, and such academic institutions as Georgetown, Northwestern, University of Virginia, Johns Hopkins, and the University of North Carolina. Four peer-reviewed papers on diverse ANAM issues saw publication in year one. These works dealt with the psychopharmacology of migraine, the natural history of recovery from concussion, and the psychometric factor structure of ANAM subtests in relation to traditional clinical neuropsychological tests.

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Introduction: Highlights, Changes, Proposed Changes and Justifications

Highlights

This past year, the ATNRC succeeded in…

- attracting and hiring a particularly promising and accomplished junior research engineer to undertake fundamental research and product development related to human movement and haptics;
- overcoming substantial technical obstacles to develop an almost-turnkey system for studying gaze behavior during exposure to virtual environments;
- fully instrumenting a therapeutic kitchen to capture timing information during performance of activities of daily living;
- implementing Automated Neuropsychological Assessment Metrics (ANAM) in brain concussion studies of the 82nd Airborne at Ft. Bragg and the US Military Academy at West Point, encompassing over 6,000 baseline assessments and demonstrating ANAM's capability as a population surveillance instrument for military and civilian health applications;
- developing informatics software for manipulating unprecedented quantities of ANAM information, and sharing that software with military and civilian ANAM users, including NASA, several Veterans Administration hospitals, and academic institutions including Georgetown, Northwestern, University of Virginia, Johns Hopkins, and the University of North Carolina;
- publishing four peer-reviewed papers on diverse ANAM issues – psychopharmacology of migraine, natural history of recovery from concussion, and the psychometric factor structure of ANAM subtests in relation to traditional clinical neuropsychological tests;
- and supporting NRH in obtaining nearly $1million for substantial enlargement of the research space available to the ATNRC and the new Neuroscience Center.

The changes presented below are divided into two groups, those which were undertaken in grant year 1 and are consistent with the ATNRC mandate approved in the our revised application submitted in November of 1999; and those for which approval *is now being sought.* None of these changes represents a change of direction for the ATNRC. All are consistent with our stated missions: evaluation and enhancement of motor and cognitive performance; assessment and support of functional activities; application of virtual reality methods for research and clinical rehabilitation; and design of new products to support independent living and clinical service delivery.

Changes During Year 1 and Rationale

Projects

Rehabilitation Engineering-based Activities

NRH Lightweight Long-Leg Brace: This project was to end during year 1 with technology transfer to Becker Orthopedic. Becker prepared several prototype braces incorporating composite materials and lightweight metal components for examination by the team at NRH. In anticipation of an in-house and ADL trial of the pre-production prototypes Becker intended to bring to market, NRH investigators Noiseux, Rosen and Halstead prepared a proposal for approval by Becker, the NRH Research Committee, and the MedStar IRB. At this point, a serious point of disagreement has emerged regarding the appropriateness of the Becker designs for insensate patients. Their intent is to produce very light braces which are fitted to the user with "total contact"; i.e. these are shell designs which conform to upper and lower leg over a large proportion of skin surface. The issue is whether individuals who do not have sensation to warn them of pressure and abrasion will have a high likelihood of developing skin breakdowns. A study of the literature and sampling of clinician opinion on a national scale is underway to decide how to proceed.

Interactive Video Exercise System (IVES): This project shared its goal with the development of Boing! and Ani-Mate (see "Body" narrative below). The common idea is to motivate compliance with a strengthening regimen by making it engaging, fun and social. The IVES system used a load cell mounted to a simple chair to allow acquisition of an isometric muscle force signal and threshold detection to do on-off control of one parameter of a game controller. Boing! is designed with a more general purpose frame which permits exercise of any body part in any direction. It will provide compliant loading as well as isometric activity. Its games are custom programmable, eventually by the clinician, using a field animation authoring program now under development called Ani-Mate. Because Boing! is essentially a superset of IVES, the budget of the latter is being absorbed into the funds for the former. The goals of the Boing!/Ani-Mate project will advance the original objective of IVES.

Evaluation of Alternative Educational Strategies for Families of Individuals with Hemi-Neglect: This project evaluated virtual reality simulation of the some of the awareness deficits which can attend left neglect. It was to have continued into technology transfer to a startup firm which had expressed interest. At this point, that company has other product-development priorities and this activity has been on hold throughout year 1. Two other firms with which ATNRC investigators interact will be contacted regarding their interest in this family training software. The VR "Shopping Cart Parking Experience" may also have a market as a training tool for patients themselves (without the awareness-obscuring features).

Deficits in Strength and Function after Excision of Soft Tissue Sarcoma of the Lower Extremity: This project, which was to close after additional data analysis in year 1, was terminated without further progress. Dr. Malawer and his orthopedist colleagues have had other research priorities and have chosen to discontinue this line of work.

Neuroscience-based Activities

Efficacy of Ginkgo Biloba for Enhancing Recovery from Stroke. This project never was started, and for reasons described below, is being withdrawn from this application.

The project began in 1995 with a survey of the world literature on cognition enhancing agents in order to identify promising agents for clinical trials to treat cognitive disorders secondary to brain injury and stroke. While the original targets of the survey were Alzheimer's drugs in clinical trials, the literature in support of a pharmaceutical preparation of ginkgo biloba, EGb 761, was very strong. We therefore, in 1996, developed a written proposal for a clinical trial for EGb 761 focused on acute stroke. Early in 1997, we contacted Schwabe Co., the German patent holder for EGb 761, and they reviewed our proposal and agreed to supply all necessary drug and placebo. The proposal was approved by the Medlantic IRB and then was submitted to the DOD IRB, which approved it in 1977, but with the condition that NRH obtain FDA sanction of this project. While NRH and Schwabe submitted the necessary FDA Investigational New Drug (IND) application in1997, FDA approval was not obtained till January of 1999, and only after NRH enlisted the assistance of the FDA Ombudsman. Unfortunately, when the FDA approval finally was obtained, NRH's 1994-1998 funding was over, and the funds which were supposed to start in October of 1998 were delayed and did not start until February of 2000, fully 18 months later.

It thus was not possible to start the study until the spring of 2000, and much had changed between 1995 and 2000. In 1995, EGb 761 was largely unknown in the US and ginkgo was not the popular nutritional supplement it has become. It would have been straightforward to undertake a placebo control group in 1995-1998, while in 2000 doing so would pose substantial challenge. First, EGb 761 now is widely available without prescription in the US. Schwabe gave Warner-Lambert an import license in 1998, and the Warner-Lambert product is advertised on prime-time television. Other ginkgo products also are heavily marketed by celebrities such as Larry King (Ginkgoba). Moreover, ginkgo extract now is included in a wide variety of foods, including Arizona Iced Teas and numerous nutritional bars. Fashioning (and verifying) a placebo group at this time would be far more expensive, requiring ongoing monitoring and verification that placebo subjects were not exposed to ginkgo, would have much higher group attrition, and would pose subject recruitment problems because there is no need to participate in the study in order to obtain treatment with ginkgo – subjects today simply can go to any supermarket or chain pharmacy and purchase EGb 761. Another important development was the publication in late1998 of the first US EGb 761 study, and Schwabe's starting a large multicenter US EGb 761 dementia trial in 1999, making the NRH study, in 2000, less unique and much less timely.

We therefore have decided that the cost/benefit ratio of this project has become decidedly less favorable and does not justify its continuation. This study consumed the majority of the neuroscience budget even in its initial form, and would consume an even greater portion if attempted today. Moreover, as noted below, we have made outstanding progress in our ANAM work and wish to maintain the momentum of that work by redeploying funds from this project to our ANAM projects. The proposal for the Fairfax County High School Concussion Surveillance Demonstration Project, to be submitted to MRMC on April 4, 2001, will describe the proposed redeployment of these funds.

Investigation of Motor Skill Learning in Post-stroke Hemiparesis Using Virtual Reality. During the 18 months with no funding, Dr. Campodonico, the PI for this study,

returned to full-time clinical work and then resigned entirely from NRH. This study was not started and there currently is no plan to do so. Unexpended funds from this study will be redeployed into the ANAM studies described below.

Stability of Cognitive Performance in Adults with Moderate-Severe Traumatic Brain Injury. This project was started in 1997 but then was discontinued during the 18 months of no funding when the research assistants conducting this highly labor-intensive study were laid off and Dr. Garmoe, the PI, returned to full-time clinical work at NRH. Most of the data for the control subjects had been collected before the study was terminated and Dr. Garmoe has returned as PI to analyze and report on these data. However, there is no plan to resume data collection for the original project, and this project will be terminated in approximately six months after Dr. Garmoe has completed his work. Unexpended funds from this study will be redeployed into the ANAM studies described below.

Staffing

During year 1, Dr. Vineet Gupta accepted a position in industry. He had been primarily involved in the virtual reality research. To succeed him, the ATNRC recruited Mr. Joe Hidler, an all-but-dissertation doctoral candidate from the Research Institute of Chicago. Mr. Hidler will defend his PhD work this Spring and continue his new position in this lab. He brings to the ATNRC very strong engineering and academic credentials in virtual reality, in particular haptic interactivity, modeling and measurement of human motor control, and electro-mechanical design for development of new clinical technologies and products for consumers with disabilities. Mr. Hidler is a wheelchair user and brings that additional perspective to the job. His resume can be found in Appendix 4.

Proposed Changes for Year 2 and Rationale

Projects

Eight RE-based projects were proposed in November 1999 for year 1, of which five were to continue into year 2 or beyond (IVES, VR for Family Ed, VR Gaze, Boing!/Ani-Mate, and Wired Independence Square). As noted and explained in the text above and the table below, four of the eight proposed year 1 projects were actually inactive during year 1. Going into year 2, the four currently active projects (VR Gaze, Boing!/Ani-mate, Wired Independence Square and Magic Walker) will continue. As shown in the table, we proposed in November of 1999 to begin two additional projects beginning in year 2, Harness Walking and the Home Evaluation Kit (HEK). That proposal should be referenced for explanatory text. The HEK will be an integrated system of tools and methods for making the assessment of a living space for suitability for a newly disabled individual faster, less expensive and more objective. The Harness Walking project was to undertake research and development on clinical application of partial-weight-bearing treadmill gait for improvement of ambulatory function in individuals with CNS injury.

The latter will be enhanced by the purchase of a Lokomat robotic gait training system from Woodway USA (Waukesha, WI) with other MRMC and private funds. This beta+ prototype

system will initially be installed in the U.S. only at NRH and the Rehabilitation Institute of Chicago. The Harness-Walking study will determine how training strategies based on partial weight bearing and robotic assistance can improve or optimize development of new movement patterns from treadmill ambulation; and evaluate reflex excitability during gait patterns in order to determine the role of joint kinematics in spasticity. This will allow us to optimize both therapeutic treatments as well as refine seating positions for optimal spasticity reductions.

In addition to the four continuing projects and the two scheduled to begin, we propose to add two more to the roster (for a total of eight). The first is development, engineering characterization, and clinical evaluation of IRIS, the Interactive Remote Imaging Station. This project began with funding from NIDRR under the Telerehabilitation Rehabilitation Engineering Research Center (RERC). Its design goal is to add roll-about portability and wireless rf communication to videophones adhering to the H.324 standard. The prototype system is based virtually entirely on off-the-shell products, including a roller stand; a 15-inch LCD monitor; a digital video camera with remotely controllable pan, tilt and zoom; a 12V sealed lead acid battery, video/audio transceivers to a base unit, and a codec for analog phone service. Design revisions are needed to extend battery life, range of wireless transmission to a base unit, human factors and economy. IRIS is meant to serve as a mobile "studio" for telerehabilitation encounters in settings where fixed videophones would be impractical. Applications outside telehealth are anticipated as well. The second new project proposed here is the development of tools and techniques for remote assessment of pressure sores. This too spun off from the Telerehab RERC. It is based on a telecare model in which a visiting nurse, home health aid, trained medical technician or other service provider would bring with her/him a teleassessment kit. The digital camera, Web access equipment, on-site computer and database management software, and other elements of this system would permit real-time or store-and-forward interaction with an expert on decubiti at a remote comprehensive rehabilitation center. Development to date has measured the degree of agreement between expert physician treatment decisions based entirely on high-quality digital still photographs (1-3 mpixel images) with decisions made from conventional on-site examination. Clinical evaluation of an early prototype system will begin soon in a rural midwestern area. We propose to transfer the development and evaluation of the technology tools to ATNRC funding. In addition to image-based assessment of sores, we propose to conduct feasibility-testing trials with non-visual sensors, i.e. means of sensing and transmitting information on tissue properties around the periphery of the sore. This could facilitate, for example, detection by modestly-trained personnel of undermining of healthy-appearing skin through changes in mechanical properties of tissue. This work would have, as a point of departure, the small current literature on palpation sensors and remote palpation in telehealth.

RE-based Project Listing

As of the end of year 4 (October 1998)	In renewal narrative (June 1999)	In revised proposal (November 1999)	Proposed Here
1: Scott Craig gait study	Done	Same	
2: Composite brace	Years 5 and 6	Year 1 only	Resolution of skin health issue pending
3: Endoprosthesis gait	Done	Same	
4: Biofeedback, IVES	"Video exercise", years 5 & 6	Same	Closed. Combined with Boing!
5: VR neglect study	Done	Same	
6: VR vs. other family-ed	Years 5 & 6	Same	Closed pending tech transfer decision
9: Sarcoma, limb-salvage	Year 1	Same	Closed. Clinical partners have other priorities.
15: Boing!	Years 5 and 6 …	Same	Continuing. See proposal "Body".
16: Ani-Mate	… combined with Boing!	Same	
19: Wired ISq	Years 5-8	Same	Continuing. See proposal "Body".
20: VR and Gaze	Years 5 - 8	Same	Continuing. See proposal "Body"
22: Magic Walker	Year 1	Same	Closing in year 2. See proposal "Body"
	Haptics in rehab	Deleted	
	23: "Harness walking", years 6-8	Retained	Retained with Lokomat added
	"Boogie Button"	Deleted	
	24: Training xfer (Vineet), yrs 6-8	Deleted upon the departure of Dr. Gupta	
	VR "Actor"	Deleted	
	25: Home evaluation kit, years 6-8	Retained	Retained

☐ signifies projects which were officially active in year 1.

Staffing

In year five, 6.84 professional FTE's were budgeted (in the budget submitted in November 1999) for the research projects based in Rehabilitation Engineering (RE). The budget for year six was the same. We propose for year 2 to allocate 8.14 FTE's to RE-based research. This change is the net effect of modest increases in most investigators' effort levels an average of 7% (-10% to +26%) and the addition of a 50% Research Operations Manager (ROM). This increase of 1.3 FTE's is made possible by economies in other budget line items. Over 8 scientific/technical FTE's means that our continuing and proposed eight projects will have roughly 1 FTE allocated per project. This should be adequate for substantial yearly progress.

Ms. Donal Lauderdale is available for the ROM position because she is partially funded for a similar role by another Center Grant (the NIDRR Rehabilitation Engineering Center on Telerehabilitation) at NRH. For a center the size of the ATNRC, the need for an individual who reports to the Director and manages the interactions of projects with each other, with the host institution and with outside organizations cannot be overestimated. Ms. Lauderdale is universally appreciated by colleagues with whom she presently works, and we in the ATNRC look forward to approval of her appointment. She has academic background and working experience in Information Systems, engineering management, and biomedical engineering. She was an undergraduate in both computer science and linguistics and is an accomplished technical writer. (Her resume is included as Appendix 2.)

Body

Projects based in the Rehabilitation Engineering Service

BOING! & Ani-Mate – A Home Exercise Arcade & Video Game Authoring System for Children with Disabilities

Status: Continuing

Principal Investigator: Dave Brennan
Co-investigators: John Noiseux, Mike Rosen
Person-months committed: 15.6 (with budgeted staff), 9 (with current staff)

Project abstract:

Children with disabilities are often limited in their recreation and physical activity, which can diminish their fitness level and self-esteem. The Boing! exercise arcade serves as a multi-purpose home gym for children in which resistance, aerobic, and range of motion exercises are performed in the context of video games that entertain and stimulate while providing motivation. Boing! is accompanied by Ani-Mate, a software system that allows for the creation of customized video games to use as an interface to Boing! The goal of this project is the development of a home exercise device for children with disabilities that will help improve control and coordination, normalize muscle tone, and increase range of motion and strength.

Year 1 Progress and outcomes:

Modifications to the existing Boing! design are ongoing. Areas that are being addressed include the bungee pulley system, monitor mount, and mouse position sensor. Upon completions of these modifications, a final next-phase Boing! will be fabricated. Contacts have been made with physical and occupational therapy staff at the Hospital for Sick Children (HSC) in Washington, DC. They have been providing input and recommendations concerning the design and potential uses for Boing!

Ani-Mate development is proceeding using Macromedia Director version 8.0. The initial list of game metaphors has been expanded based upon conversations with clinical staff and patients at HSC. A game template has been developed that incorporates the ability to customize the appearance of the game (backgrounds and characters), speed, and degree of difficulty based on the preferences of the game user and clinicians. In addition the software will store the preferences as well as record game performance and progress.

Continuation plan:

Following fabrication of the next-phase Boing!, the device will be "field-tested" ,along with the improved Animate software, at HSC. The "field testing" is expected to last from 1 to 2 months and will collect data on Boing!'s efficacy in meeting therapeutic goals as well as feedback from users (clinicians, patients, and family members) regarding both Boing! and Animate. This feedback will serve as a basis for additional modifications to the design of both Boing! and the Animate software. In the future a larger scale research study will include a more structured evaluation method that will look at a greater number of patients over a period of approximately six months. In the study, Boing! users' fitness gains will be measured using cardiac capacity, coordination, and range of motion.

Wired Independence Square

Status: continuing

Principal Investigator: J. Carter
Co-investigators: M. Rosen

Project abstract:
Assessment of patients' functional status in a rehabilitation setting is typically done by an observing therapist using a subjective rating scale such as the Functional Independence Measure (FIM). As a method to introduce objectivity and "ecological validity" into the assessment process, engineers from the Assistive Technology & Neuroscience Research Center (ATNRC) at the National Rehabilitation Hospital (NRH) are installing sensors into the Independence Square® (ISq) recently constructed in the hospital. The aim is to add objective data to a patient's chart without requiring additional time or effort from the physical, occupational, or speech therapist. With the acquisition of the Rehabilitation Engineering Research Center (RERC) on Telerehabilitation (funded by the National Institute on Disability and Rehabilitation Research, NIDRR, of the U.S. Department of Education), the project has been expanded to further develop the system for use outside the hospital in clients' homes.

Year 1 Progress and outcomes (short enough to confine this two pages or less):
Year 1 saw many advances in the progress of this project. The set of sensors installed in the kitchen of has been greatly expanded from being just on items used in making a cup of tea, to on virtually all possible on-off, open-close items. A junction box has been fabricated which includes the necessary circuitry to power the sensors, ground the incoming signals, and prepare the signals to be read and recorded by the software. All of the connections have been verified, however, successful recording of data from all of the sensors is not complete. The software has been modified into a version 2 of the display and was demonstrated. However, this version was made before all the sensors were installed, so a major revision in the software is needed.

Also in Year 1, we began an offshoot project looking at the effects of visual feedback to the patient upon completion of a treatment session in Independence Square. As implied, this portion of the project presents data to the patient, as well as to the therapist. The three questions this research hopes to answer are 1) does visual plus verbal feedback enhance the degree of verbal awareness of strategies, compared to verbal feedback alone, 2) does such enhanced awareness lead to concomitant improved implementation of strategies, and 3) does the improved implementation of a strategy improve performance on functional tasks. The verbal feedback will be nothing different from that which is provided in an ordinary treatment session. The visual feedback will be presented via a computer using images captured during the treatment session from a continually running camera. The portions of a treatment session that will be recorded and reviewed following the session will be determined by the therapist who will press a handheld "record" button at times during the session that s/he would like to review. Pressing the record button triggers a PC to save images from a specified interval before the button was pressed to a specified interval after it is pressed.

Continuation plan:
A detailed outline has been developed to guide the continuation of this project. Within the next year, several deliverables have been detailed. The first steps involve completing the hardware installation and data delivery. This includes the successful recording of data from all the sensors, and its display. Within 3 months, the next version, version 3, of the data display will be programmed and demonstrated to therapists for comment. Testing of the system with therapists and patients using version 3 of the software will follow, and based on results from the testing, version 4 will be designed. During this upgrade period, preparations will be made for submission of a proposal to the IRB committee for a detailed study. By the end of Year 1, study 1 will be underway.

For the Visual Feedback project, we expect to have a pilot study proposal submitted within the next month, followed by the actual study. Pending the results, future studies will be planned.

Virtual Reality Display and Gaze Monitoring to Investigate Impairments of Visual Processing of Social Stimuli, RE20

Project Number: 20 **Status: Continuing**

Principal Investigator: C. Trepagnier
Co-investigators: M. Sebrechts, J. Hidler, R. Peterson Person-months committed: 14

Project abstract:

Social perceptual deficits are a significant barrier to independence for many individuals with traumatic brain injury, stroke, and autism. This project will develop virtual environments presenting a variety of social contexts in which persons with disabilities can make behavioral choices that might put them at risk in real environments. Data representing these choices is expected to provide a more ecologically valid and predictive assessment of patients' functioning than can self-report. Results of initial experiments will be used to develop an assessment of social perception and judgment.

Year 1 Progress and outcomes:

Personnel *Engineer*: Departure of the virtual-reality engineer (V. Gupta) for industry has delayed progress in this project. The department posted an opening for a doctoral-level VR engineer; however the selected candidate elected to accept a higher-paying position in industry. The project has benefited from a 3-month, part-time intern (J. Wijpkema), who has developed real-time fixation detection, a capability necessary for a visual environment that will respond to the viewer's direction of gaze. As of last week, the department has been joined by a doctoral-level engineer (J. Hidler) whose research interests are in motor control but who is providing engineering support to the project while we search for someone who will devote her/himself to visual world development. *RA*: A doctoral student in clinical psychology (R. Peterson) has joined the project, contributing skills in statistical analysis and testing.

Re-design and evaluation of Head-Mounted Display with Eye-Tracking (VR-EYE) Comfort and tolerability of the department's VR-EYE system has been greatly improved by a group of CUA seniors carrying out a design project under the supervision of the director of the department (M. Rosen). The interface to the head is now a catcher's helmet, with counterbalancing in the back now compensating for the weight of the camera in front, and an inflatable bladder inside the helmet for cushioning and stabilization. Further modifications are planned.

Review of social assessments Review of instruments used for assessment of social perception and behavior is being carried out by the psychology graduate student.

Development and preliminary evaluation of gaze-contingent software Software has been developed in C that provides for fixation detection for stationary gaze targets and smooth pursuit. Fixations can be displayed in real time or kept invisible, and can be used as inputs to the display. A demonstration was constructed in which the viewer's gaze at one or the other of a clown's ears caused the clown's head to spin clockwise or counterclockwise, respectively.

Global vs. local perceptual bias in autism Data has been gathered from 10 individuals with autistic spectrum disorder and 13 controls on the Embedded Figures Test (in which persons with autism are reported to be at an advantage) and an experimental task investigating preference for global or local perception. Data analysis is in progress. Results of this study, which is part of a doctoral thesis (S. Johnson) (M. Sebrechts, supervisor; C. Trepagnier, member of committee) will be useful in the design of virtual environments for this population.

Continuation plan :

Personnel The VR engineer position has been re-posted. We are also actively considering a candidate engineer interested in further development of visual VR skills, rather than restricted to an expert VR engineer. A bachelor's level project engineer is also being sought. This person would, among her/his duties, carry out software development under the senior engineer's supervision.

Development and preliminary evaluation of gaze-contingent software Work is now proceeding on a Windows interface to this software, to facilitate control of parameter values.

Adaptation / development of virtual worlds as social contexts This component of the project will advance now that a doctoral level engineer has joined the staff.

Design of VRs Analysis of data from Study Preliminary analysis of the data from a study of Gaze Monitoring during Face and Object Recognition, conducted under other funding (RERC), is expected to be completed within the next month. This study offered static, isolated faces or objects, to determine whether, in the course of remembering and identifying stimuli as previously seen or not previously seen, experimental populations would differ from controls in regard to how they examined the stimuli. Preliminary analyses of these data will be used in making a decision as to whether initial social contexts to be developed in the present project should be immobile or moving, and whether they should include multiple 'distractors' as well as representations of people.

Magic Walker w/ Brakes

Status: Continuing

Principal Investigator: John Noiseux
Co-investigators: Richard Keller, Joe Hidler

Project abstract:
The goal of this project is to develop a braking mechanism for the Magic Walker. The Magic Walker is an assistive walking device that enables children to ambulate who are unable to do so independently due to lower limb weakness, poor balance, poor coordination, etc. The inclusion of a braking mechanism will increase the user's safety and increase the child's independence while using the device.

Year 1 Progress and outcomes:
During the last year evaluation of the fabricated walker was stalled when the identified user underwent several surgical procedures. During this period various brake configurations have been considered. A preliminary brake design has been identified using torsion rod elements. The rear wheels of the walker will each be attached at one end of lever arms such that, when the child is applying load to the walker seat, they will apply a torque to the torsion rod element and, if the force is great enough, cause the wheels to contact a braking surface. Essentially, the weight of the child on the seat will induce brake activation. The brakes will be configured in order to allow them to be adjusted to the user's weight and degree of support required from the seat. At this time the machinist associated with this project is developing several test configurations to determine the most appropriate configuration and materials. Other braking options continue to be considered.

Continuation plan:
During the coming year the configuration of the brakes will be finalized and a prototype of the walker incorporating the brakes will be fabricated. Partnerships for evaluation and commercialization will be pursued.

Projects Based in Neuroscience

Automated Neuropsychological Assessment Metrics (ANAM): Psychometric Development and Integration into Military and Civilian Studies of Cerebral Concussion and Psychopharmacologic Treatment of Brain Injuries and Diseases

Year: 1
Principal Investigator: J. Bleiberg (NRH)
Co-Investigators: D. Reeves (U.S. Navy), R. Kane (Veterans Administration and NASA), J. Barth (U. Va.), T. Elsmore (Private Consultant), and K. Winter (U.S. Naval Computer and Telecommunications Station, Pensacola)

Abstract:

This project develops cognitive assessment technology, implements that technology in clinical neuroscience research projects, and uses the results of that research to further refine the technology. We began the year having just completed a major psychometric validation study for Automated Neuropsychological Assessment Metrics (ANAM), and the initial task was to prepare and publish our findings. Our next task was to use the psychometric validation data to create an empirically-derived ANAM battery with minimal redundancy across tests, and then to utilize that battery in a variety of ongoing clinical neuroscience studies. This objective also has been achieved, and ANAM currently is serving as a major outcome measure in studies of sports concussion, breast cancer quality of life, chronobiology, lupus, and multisystem illnesses such as chronic fatigue syndrome and Gulf War Syndrome. In addition, the NRH-ANAM is part of a number of planned studies on cognitive effects of substance abuse treatment, testosterone replacement, omega-3 fatty acid supplementation, paratrooper helmet designs, neuroprotectant properties of pyruvate-creatine, and acetylcholinesterase inhibitor treatment of Alzheimer's disease. Lastly, to pursue our interest in the NRH-ANAM as a public health population surveillance instrument, we have formed a collaboration with Kaiser Northern California for a pilot project to integrate ANAM into primary care medical practices.

Year 1 Progress:

Publication of our ANAM psychometric validation project (Bleiberg, Kane, Reeves, et al., 2000) helped in establishing the credibility of using ANAM as a core component of major research projects.

The next step in developing ANAM was to create a large user base. A large user base allows for the software to be tested in a variety of settings, using a variety of populations, and creates a corpus of scientific literature in which ANAM is used successfully by well-respected investigators and institutions. As part of creating the ANAM user base, the principal investigator has conducted numerous ANAM lectures and workshops, has worked with interested investigators to integrate ANAM into ongoing or proposed research projects, and has provided ongoing technical assistance to these projects to ensure successful implementation.

The identification of NRH as a source of ANAM expertise for a broad range of neuroscience research also serves NRH's long-term goal of being considered by pharmaceutical companies to be a credible partner for clinical trials of medications to treat neurologic disease and injury.

Below is a listing and brief description of projects comprising the ANAM user base:

1. West Point Boxing Study. In the spring of 1999, NRH was invited to collaborate with a planned Defense Veterans Head Injury Program (DVHIP) study of boxing concussion at the U.S. Military Academy at West Point. The ANAM psychometric validation project (Bleiberg, Kane, Reeves, et al., 2000) was used as the basis for developing a "concussion optimized" version of ANAM for use in this study. In July of 1999, this ANAM battery was administered to the incoming West Point freshman class. Athletic trainers re-administered ANAM at one-hour, 24-hour, and 96-hour intervals following boxing concussions. The resulting paper (Warden, Bleiberg, Cameron, et al., in press) provides a high resolution description of the natural history of concussion, at a level of detail previously unavailable. The unexpected nature of the findings -- which were provocative and raised novel sets of questions -- led to an expansion of the study the following year. In July of 2000, we again obtained ANAM baselines for that year's entering class. However, the research protocol now included the use of matched control subjects for each injured cadet, and the intervals of study were extended to include 10-day and 30-day assessments. Data collection for the current project is proceeding entirely on schedule and the plan is for the principal investigator to go to West Point in April 2001 to collect the data for analysis, interpretation, and publication. (The DVHIP principal investigator for the West Point project is Deborah Warden, M.D.)
2. Fort Bragg Concussion Study. This also is a DVHIP study which NRH joined in the spring of 1999. The subjects are the 82nd Airborne and the design is to baseline as many soldiers as possible and then retest them following concussion. Progress to date has consisted of baseline examinations for approximately 5000 soldiers, with post-testing of 40 concussed soldiers. We currently are analyzing the data from this study as part of two projects, one to use the 5000 baselines to develop ANAM norms, and the other to use the sample of 40 concussions to replicate and extend the West Point study. DVHIP plans next year to redeploy the resources from this project into a duly approved study comparing different helmet designs in protecting paratroopers from concussion and other injury. NRH has been invited to participate in the helmet study and ANAM will be one of the primary outcome measures.
3. Fairfax County High School Concussion Project. This project has three objectives. First, is to develop a model program for high school sports concussion surveillance and management, utilizing newly developed instruments such as the NRH-ANAM, the Virginia Neurological Index (VNI), and the Standardized Assessment of Concussion (SAC). Second, is to generate a detailed description of natural history of recovery from sports concussion in male and female adolescents, with special emphasis on the female athletes who heretofore have not been well covered by previous research. And third, to develop an Internet-enabled version of ANAM and use the Fairfax project as a testbed for psychometric validation of the Internet version against the conventional version of ANAM. Improved understanding of recovery from concussion will be used

to refine current sports concussion management guidelines. The University of Virginia at Charlottesville has been conducting ongoing sports concussion studies with the Fairfax high school system for several years. The original plan was for NRH to provide a subcontract to the University of Virginia to cover the additional expenses of including ANAM as part of their ongoing research. However, in the interim, the University of Virginia's funding was not renewed. Because of the major significance of this study, we plan to resubmit this project entirely under NRH funding. To this end, we have received written invitation from the Fairfax County superintendent of schools for NRH to conduct the study and have nearly completed writing the proposal for this study. Our plan is to have the protocol completed by March 30, 2001, to pilot test the protocol in May-June, and start active data acquisition in August of 2001. Concurrently, we will establish a subcontract with Kathy Winter of the Naval Computer and Telecommunications Station, Pensacola, for development of the Internet technology. Dr. Barth of the University of Virginia will continue as a coinvestigator, in the role of consultant. Dr. Broshek of the University of Virginia, an expert in gender differences in recovery from brain injury, and Mr. Jon Almquist, chief athletic trainer for the Fairfax County school system, also will serve as coinvestigators/consultants.

4. Georgetown University CFS Studies. Dan Clauw, M.D., Chief of Rheumatology at Georgetown, is conducting studies of multisystem illness under MRMC support. In June of 2000, Dr. Grate of MRMC, thinking that ANAM would be useful to the Georgetown research, requested that Dr. Bleiberg meet with Dr. Clauw and demonstrate the ANAM software. This was accomplished in July and Dr. Bleiberg prepared an ANAM battery to Dr. Clauw's specifications, and trained his research assistants in administration, scoring, and use of NRH's database software. Data collection for this study is ongoing and NRH will provide technical assistance for data analysis and interpretation.
5. Indiana Wesleyan University Breast Cancer Quality of Life Study. Michael Boivin, Ph.D., recently started a Catholic Charities funded study exploring quality of life, neuropsychological functioning, and immunological response in women with early-stage breast cancer. An underlying premise of the study is that cognitive function is a central feature of quality of life and that cancer treatments should be evaluated for side-effect profiles which include their effects on cognitive function. We have provided technical assistance to Dr. Boivin in the form of creating an ANAM battery for his study and then training him in how to use it. This study is significant in that it can demonstrate ANAM's utility for studying the cognitive dimensions of quality of life. Quality of life likely will become increasingly important in pharmaceutical development and we believe ANAM can play a significant role in facilitating this area of research.
6. University of Virginia and Johns Hopkins Breast Cancer Quality of Life Study. This Johnson and Johnson Company sponsored study examines a wide range of computerized and traditional neuropsychological measures to identify an optimal set of measures for upcoming trials of chemotherapy adjutants designed to minimize side-effects. ANAM will be included in this study.
7. Northwestern University Medical School Chronobiology Laboratory. In October of 2000, Joseph Bleiberg, Ph.D., gave an ANAM workshop to Phyllis Zee, M.D., Ph.D.,

Director, Sleep Disorders Center, and her chronobiology laboratory colleagues, resulting in the development of a formal collaboration for NRH to assist Dr. Zee and her colleagues in using ANAM for a series of studies including effects of exercise on sleep in geriatric populations and effects of galantamine on arousal and attention in Alzheimer's patients.

8. The Kronos Institute. The Kronos Foundation is a newly created nonprofit organization in Phoenix, Arizona, headed by Mitchell Harmon, M.D., Ph.D., an endocrinologist and former director of the NIA. The primary focus of the Kronos Foundation research program is to explore ways to prevent or delay cognitive and physical deterioration associated with aging. We have been invited to introduce ANAM into two of the Foundation's planned studies, one on omega-3 fatty acid supplementation and the other on testosterone replacement therapy. The Kronos collaboration provides NRH with a vehicle for exploring ANAM's utility in performance enhancement research. Moreover, it is not unreasonable to assume that some performance enhancement research will have applicability to the fields of rehabilitation medicine and military medicine.
9. Kaiser Northern California/Kaiser Research Institute. Following six months of discussions, Kaiser and NRH formally agreed to develop a pilot project to introduce ANAM assessment into primary care medicine. The initial focus of the project will be to solve the technological problems in inserting ANAM software into the current Kaiser Permanente medical practice management software system, the purpose being to turn any computer station in a Kaiser medical facility into an ANAM testing station. This component is scheduled to start in June of 2001 and will be followed by development of a protocol for population-based surveillance of a subgroup of Kaiser patients. The two subgroups under current consideration are Parkinson's patients and brain injury patients, and depending upon logistics it is probable that both patient groups will be selected. Once we have demonstrated the capacity to follow an ongoing large population of patients, we believe we will have demonstrated the technological feasibility to conduct relatively inexpensive population-based longitudinal studies of dementia and other neurodegenerative conditions. An inexpensive way of longitudinally monitoring groups for early identification of onset of dementia will become invaluable when effective drugs for stopping or reversing dementing illnesses become available.

Continuation Plan:

This project has grown so much and branched so many times that it will be broken into multiple, discrete projects, as follows:

The Fairfax County High School Concussion Project will become a separate project with its own budget, to be submitted April 4, 2001. This project will incorporate Internet-based and handheld-based cognitive testing, including psychometric validation of ANAM on these new platforms.

The Kaiser Northern California Project will become a separate project with its own budget (to be developed pending further discussions between NRH and Kaiser Research

Foundation regarding implementation plan and resource/cost sharing). It is anticipated that a formal proposal for this project will be submitted to MRMC in July 2001, with an approximate budget of $50,000 per year for three years. This project will focus on the integration of cognitive assessment into primary-care medicine.

Many of the ANAM projects consist of collaborations in which NRH directs and manages the ANAM component of studies sponsored by other institutions. The major advantage of engaging in these collaborations is that they are an extraordinarily powerful way of leveraging NRH's and DOD's research dollars, rapidly and efficiently expanding the ANAM user-base and facilitating the creation of a vibrant ANAM user community. Moreover, each of the collaborative projects contains a scientifically important neuroscience research problem. We propose to aggregate these types of projects into a program core of "ANAM Dissemination, Support, and Technical Assistance," with a single budget that has provisions for support of the above described projects, as well as for stimulation and support of new projects.

The specific activities included in the ANAM Dissemination, Support, and Technical Assistance core are:

1. Consultation between NRH personnel (Drs. Bleiberg, Kane, or Reeves) and outside investigators to determine if ANAM is an appropriate tool for a proposed study, and to determine whether the proposed study is of sufficient quality to justify investment of NRH-DOD resources
2. Provision of an ANAM "workshop" to the investigator's laboratory or institution, including installation of ANAM and training in its use
3. ANAM software modifications and enhancements to address specific needs of the proposed study, typically performed under subcontract from NRH to Navy Computer Telecommunication Station (NCTS) and/or Tim Elsmore, Ph.D.
4. Provision of assistance to outside investigators for writing ANAM-related sections of research proposals, IRB submissions, and study procedure manuals
5. Data extraction, data management, and data analysis for ANAM and related data (e.g. Drs. Bleiberg and Reeves have collected the West Point baselines for the past two years and are performing the West Point and Ft. Bragg data analyses)
6. Participation in delivering scientific papers and posters, and preparation of papers for publication
7. (Planned for July of 2001) an "ANAM-Central" web site, currently under development by NCTS under subcontract from NRH, where ANAM users can communicate with one another, download updated ANAM files, stay informed of studies employing ANAM software, and share data (one investigator's experimental group often can be another investigator's control group; aggregation of multiple investigators' data sets can provide normative bases)

Key R&D Accomplishments

- Ani-Mate: Using Macromedia Director version 8.0, a game-authoring template has been developed that permits clinicians to customize the appearance of a therapeutic game (backgrounds and characters), as well speed, and degree of difficulty based on the preferences of the game user and clinicians. The initial list of game metaphors has been expanded based upon conversations with clinical staff and patients at Hospital for Sick Children in Washington, DC.
- Wired Independence Square: The kitchen area of NRH's Independence Square installation is now completely instrumented with event-detection sensors and circuitry for power, processing and transmission to the host computer. This facility is unique in clinical rehabilitation.
- Virtual Reality and Gaze Detection: Comfort and stability of the ATNRC's VR-EYE system has been greatly improved by a group of CUA seniors carrying out a design project under the supervision of the director of the department (M. Rosen). The interface to the head is now an adapted catcher's helmet, with counterbalancing in the back now compensating for the weight of the camera in front, and an inflatable bladder inside the helmet for cushioning and stabilization.
- Virtual Reality and Gaze Detection: Software has been developed in C that provides for fixation detection for stationary gaze targets and smooth pursuit. Fixations can be displayed in real time or kept invisible, and *can be used as inputs to the display*. A demonstration was constructed in which the viewer's gaze at one or the other of a clown's ears caused the clown's head to spin clockwise or counterclockwise, respectively.
- Virtual Reality and Gaze Detection: Data has been gathered from 10 individuals with autistic spectrum disorder and 13 controls on the Embedded Figures Test (in which persons with autism are reported to be at an advantage) and an experimental task investigating preference for global or local perception. Data analysis is in progress. Results of this study, which is part of a doctoral thesis (S. Johnson) (M. Sebrechts, supervisor; C. Trepagnier, member of committee) will be useful in the design of virtual environments for this population.

Reportable Outcomes

Publications:

Bleiberg, J., Kane R., Reeves, D., Garmoe B., & Halpern, E. Factor analysis of computerized and traditional tests used in mild brain injury research. *The Clinical Neuropsychologist*, 14(3), 2000.

Farmer, K., Cady, R., Bleiberg, J., & Reeves, D. A pilot study to measure cognitive efficiency during migraine. *Headache*, 2000, 40(8):657-661.

Farmer, K., Cady, R., Bleiberg, J., Reeves, D., & Putnam, G. Sumatriptan nasal spray and cognitive function during migraine: Results of an open-label trial. *Headache*, in press.

Lathan, C.E. & Tracey, M. The interaction of spatial ability and motor learning in the transfer of training from a virtual to a real task. *Presence:Teleoperators and Virtual Environments.* MIT Press, submitted.

Noiseux, J. & Clawson, C. A Blue Print for Accomodation - on workplace accommodation. *RehabManagment Magazine.* Los Angeles: December/January 2000/2001.

Sebrechts, M. M., Lathan, C. E., Clawson, D. M., Miller, M. S., & Trepagnier, C. (in press, 2000). Transfer of training in virtual environments: Issues for human performance. In L. J. Hettinger & M. W. Haas (Eds.). *Psychological Issues in the Design and Use of Virtual, Adaptive Environments.* Mahwah, NJ: Lawrence Erlbaum Associates.

Tracey, M., Lathan, C.E., & Blanarovich, A.M. Using Virtual Reality and Vibrotactile Stimulation to Achieve Functional Goals. In *Assistive Technology on the Threshold of the New Millenium*, C. Buehler & H. Knops (Eds.), IOS Press: Amsterdam, 2000.

Warden, D., Bleiberg, J., Cameron, K., & Ecklund, J. Persistent prolongation of simple reaction time in sports concussion. *Neurology*, in press.

Conference Presentations (with proceedings):

Blanarovich, A. M. Design of personal augmentation devices (PADS): Exploratory play agents for children with severe disabilities, Proc. Rehabilitation Engineering Society of North America (RESNA), Orlando, FL, July, 2000. Student Paper Award Winner.

Rosen, M.J., Brennan, D., Trepagnier, C., Tran, B., Lauderdale, D. & Toman, A. Dimensions of diversity in design of telerehabilitation systems for universal usability. Proceedings of the Conference on Universal Usability (CUU 2000), 61-62.

Rosen, M. J., Noiseux, J., Bowman, T., & Burns, R. Telerehabilitation and Homecare Technologies: Status, Prospects, and Coordination. Concurrent Session at RESNA 2000 Annual Conference, Orlando, June 28 – July 2, 2000.

Tracey, M., Lathan, C.E., & Blanarovich, A.M. Using Virtual Reality and Vibrotactile Stimulation to Achieve Functional Goals. Medicine Meets Virtual Reality, Newport Beach, CA, January, 2000.

Trepagnier, C., Gupta, V., Sebrechts, M. & Rosen, MJ. How does he look: Tracking autistic gaze. In Proceedings of the RESNA 2000 Annual Conference , July 2, 2000.

Trepagnier, C., Halstead, L., Dang, T. M., Schroeder, M.A., & Rosen, M.J. Distributed Expertise: Remote Support for Direct Service Providers" Proceedings of the California State University at Northridge Conference on Technology and Persons with Disabilities, January 27-30, 2000, web publication http://www.csun.edu/cod/conf2000/proceedings/0213Trepagnier.html (Presented by L. Halstead, J. Noiseux and L. Thiel).

Trepagnier, C., Sebrechts, M., Gupta, V., Johnson, S., Piller, M., & Rosen, M.J. Application of Virtual Reality Display for Assessment and Rehabilitation of Nonverbal Communicative Interaction. paper presented at Medicine Meets Virtual Reality (MMVR), Newport Beach, CA, January 27, 2000.

Other Invited Presentations, Demonstrations, and Talks without Proceedings:

Halstead, L.S. *The Power of Compassion and Caring in Rehabilitation Healing*. The 49th Annual John Stanley Coulter Memorial Lecture at the 77th Annual Meeting of the American Congress of Rehabilitation Medicine, Hilton Head, SC, October 2000.

Lathan, C.E., Blanarovich, A.M., & Vice, J.M. *Tele-Play*. Strong Angel Humanitarian Effort, Hawaii, June, 2000.

Lathan, C.E. & Tracey, M. *Personal Augmentation Devices (PADs): Developing a Therapeutic Teleplay System for Children with Disabilities*. Society of Women Engineers National Conference (Best Technical Paper Award). Washington, DC, June, 2000.

Noiseux, J. *Workplace Accessiblity/Accommodation,* The Maryland Worker's Compensation Education Association's 16th Annual conference. September 2000

Noiseux, J. *Home Accessibility*, the Myositis Association of America 2000 Annual Conference, October 2000.

Rosen, M.J. *Telerehabilitation: Prospects and Progress*, New York Academy of Medicine, Feb. 3, 2000.

Rosen, M.J. *Applications of Virtual Reality in Rehabilitation*, Biomedical Engineering Seminar at U. Minnesota, , March 14, 2000

Rosen, M.J., U. Minnesota minicourse on *Telerehabilitation and Unobtrusive Functional Sensing* for graduate students and faculty, March 15, 2000.

Rosen, M.J. *Telerehabilitation: Rationale, Obstacles and Progress*, Marquette University BME seminar, April 14, 2000.

Rosen, M.J. *Telerehabilitation Design Issues*, session on Advanced Technology Applications for Product Design at 44th Annual Meeting of the Human Factors and Ergonomics Society, July 29 – Aug. 4, 2000

Rosen, M.J. *Design Challenges in Telerehabilitation*, Human Factors and Ergonomics Society Conference, San Diego, August 3, 2000 (substituting for Cori Lathan).

Rosen, M.J.T*elerehabilitation Design Issues*, invited talk at NASA-Ames Research Center, Moffet Field, CA, August 8, 2000.

Rosen, M.J., Brennan, D., Noiseux, J., & Trepagnier,C. *Demonstration on IRIS* at celebration of tenth anniversary of ADA at residence of Vice President Gore. July 25, 2000.

Rosen, M.J. *Telerehabilitation: Prospects and Progress,*" invited short course for American Society of Neurological Rehabilitation, Rochester, October 5, 2000.

Rosen, M.J. *Virtual Reality in Rehabilitation*, invited short course for American Society of Neurological Rehabilitation, Rochester, October 5, 2000

Rosen, M.J., & Bassen, H. *Biomedical Engineering 497, Biomedical Engineering Product Design*, required senior projects course at Catholic University of America, fall semester, 2000

Trepagnier, C. *Eye-tracking Research in Autism* presentation at NASA-Ames Research Center, Moffet Field, CA, August 8, 2000.

Trepagnier, C. *Audio Teleconference on Telerehabilitation: Current and future.* Invited presentation to Assistive Technology centers as part of a series sponsored by RESNA. September 20, 2000.

Trepagnier, C. *Research in Autism.* Invited presentation made to the Montgomery County Chapter of the Autism Society of America. Silver Spring, MD. Feb 29, 2000.

Trepagnier, C. *Virtual reality and eye-tracking research in rehabilitation.* Invited seminar for graduate engineering course at the Catholic University of America, October 23, 2000.

Trepagnier, C., Sebrechts, M., Gupta, V., Johnson, S., Piller, M., & Rosen, M.J. *Using HMD-Embedded Eye-Tracking to Assess Autistic Visual Information Processing: Preliminary Eye-Gaze Analysis.* Poster presented at the 41st Annual Meeting of the Psychonomics Society, November 2000, New Orleans.

Proposals Submitted based on ATNRC accomplishments

- A proposal is currently in preparation to the U.S. Army Medical Research and Materiel Command. It proposes the content for a new Congressionally mandated Neuroscience Center. That content is based, in part, on the ATNRC's accomplishments and research directions in virtual reality, analysis of gaze behavior, high-resolution assessment of cognitive function, and evaluation of neuroprotectants. That proposal will be submitted in May of 2001.

Gait Restoration in Stroke and Incomplete SCI Patients Using a Robotic Lokomat Treadmill

The primary goal of this study is to track the short- and long-term effects of robot-assisted treadmill training in subjects with stroke and incomplete spinal cord injury. Specifically, we would like to determine whether treadmill training with a Lokomat external orthosis improves walking capabilities in stroke and incomplete SCI subjects

while at the same time decreases secondary complications such as spasticity. Using this device, we will address three specific research questions.

1: Determine to what degree prolonged training with this bi-lateral robotic orthosis improves gait kinematics and stability in subjects with incomplete SCI or hemiparesis.

2: Assess if repetitive locomotor movements train "central pattern generators" which may be triggered to produce functional gait in patients who present with weakness and/or inappropriate muscle synergies.

3: Quantify reductions in secondary complications such as spasticity and abnormal muscle tone, by comparing these phenomena before and after Lokomat gait training.

Development of a multi-joint robotic device used for rehabilitation : A collaboration between Biodex Medical Systems and the National Rehabilitation Hospital (NRH)

The long-term objective of this research is to develop a robotic device which can be used in two distinct capacities. As a therapeutic tool, this device will be used by patients with motor impairments in the upper extremities, where the robot can provide active assist or resist during tasks as simple as reaching. As a diagnostic tool, it will provide clinicians with accurate assessments of the patients motor impairment and track the progress of functional recovery. Furthermore, the device can diagnose the patients level of impairment by running a battery of motor tasks, from which it can design a custom therapeutic program on a patient by patient basis. Combining both clinical and experimental studies, the hope is to better understand the changes in neuro-muscular properties which accompany stroke so that we can offer better therapeutic and pharmacological treatments for a patients recovery.

Conclusions

PLEASE NOTE:

All conclusions have been incorporated into each project's narratives in the previous sections.

Appendices & References

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Curricula Vitae

Education: MSE, Engineering Management, The Catholic University of America expected 2001; BSCS, University of Maryland 1987

Pertinent Experience:

Research Operations Manager, RERC on Telerehabilitation. The Catholic University of America, Washington, DC. 1999-present.

- Manage RERC CUA subcontract financial functions; laboratory and administrative operations of the HomeCare and Telerehab Technology Center.
- Serve as co-principal investigator on the Telerehab Virtual Library, web-based information dissemination system Prepare and disseminate technical reports on Center evaluation of telerehab systems. Coordinate demonstrations of Telerehab RERC r&d projects. Organize conference participation, presentations, open houses for VIPs, developing and prospective students.
- Work with interdisciplinary team to assess needs and develop telerehab systems for the islands of the Pacific. Coordinate with other government agencies and grantees with mandates in the Pacific jurisdictions.

Systems Analyst, Systems Division, Georgetown University Hospital. 1989-1993.
Planned and implemented systems modifications in heterogeneous networked computing environment. Wrote proposals, trained and supervised programming staff. Interfaced with diverse medical and academic users, performed needs assessments, consulted on human factors considerations.

Programmer, Systems Division, GUH.1988-1989.
Modification and maintenance of hospital information systems software in the areas of patient registration, radiology and pathology. Implemented first voice recognition reporting system in radiology.

Administrative Officer, Systems Division, GUH.1986-1987
Managed divisional administrative functions. Hiring of staff, payroll, preparation of budgets, management and maintenance of facilities.

Disability Community Involvement:

Board Member & Trisomy 18 Coordinator. Chromosome 18 Registry and Research Society, University of Texas at San Antonio Health Sciences Center. 1996-98.

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EDUCATION

Ph.D. in Biomedical Engineering, Northwestern University, Expected May 2001

- Specialized in investigating changes in neural circuits and muscle properties in spinal cord injured subjects which may lead to abnormal reflex function and spasticity.
- Dissertation topic: "Experimental observations and theoretical predictions on the origins and behaviors of clonus."
- Research Advisor: W. Zev Rymer

M.S. in Biomedical Engineering, Northwestern University, June 1996

- Thesis: "Reflex instability in spasticity: origins of clonus."

B.S. in Mechanical Engineering, University of Massachusetts at Amherst, May 1994

RESEARCH EXPERIENCE

Senior Research Engineer, Rehabilitation Engineering Services, National Rehabilitation Hospital, Washington, DC, January 2001 – present. Responsible for developing robotic devices used to quantify neuropathology following stroke and traumatic brain injury, investigate the role of gait assisted treadmill training on spasticity and motor impairment in spinal cord injury and stroke, and develop adaptive learning algorithms in mechatronic devices which will optimize therapeutic treatments for neurological patients.

Research Associate, Sensory Motor Performance Program, Rehabilitation Institute Of Chicago, Chicago, IL September 1997 – January 2001. Research areas included quantification of muscle spasms in patients with spinal cord injury, investigation of the neuropathology of spasms and movement impairment, and development of dynamic models of reflex circuits in order to better understand neuromusclular changes in spastic subjects.

Research Assistant/Biomedical Engineer, Northwestern University, Evanston, IL, June 1995 – 1997. Developed a dynamic model of the human ankle reflex pathway for studying instability in spasticity. Designed and built experimental setup used to study motor control strategies in humans while executing point-to-point movements.

Mechanical Engineer, Energy Research Lab, University of Massachusetts, Amherst, MA, May 1993 – September 1993. Investigated radiation view factors in heat transfer applications by developing a model of thermal flow from source to target. Developed computer software to investigate heat transfer through various thermal mediums, including radiation, conduction, and convection environments.

TEACHING EXPERIENCE

Northwestern University, Guest lecturer in graduate course in Biomedical Engineering: "D69 – Neural Control and Mechanics of Movement". Prepared and taught a session on reflex function and analysis in normal and spastic subjects. Primary Instructor: W. Zev Rymer, Ph.D.

Northwestern University, Instructor, National High School Institute, Evanston, IL, Summers, 1995-1999. "Exercise Science and Physiology". Created, prepared and implemented course lectures and discussion sections during the 5-week summer program. Prepared and graded written assignments and exams, organized and taught multiple lab sections.

University of Massachusetts, Teaching Assistant, Department of Mechanical Engineering, Amherst, MA, Spring 1993. "Thermodynamics I". Taught weekly discussion section and review sessions for exams. Assisted in the preparation of course materials and homework assignments. Graded weekly assignments.

MANAGEMENT EXPERIENCE

Lab Manager, Sensory Motor Performance Program, Rehabilitation Institute Of Chicago, Chicago, IL September 1997 – January 2001. Built and maintained a robotic device used for human experimentation. Designed hardware circuitry, including signal conditioning, filters, and communications hardware for interfacing data acquisition boards. Wrote custom 32-bit Windows DAQ software, *WinA2D*. Designed real-time controller for robot capable of multiple modes of operation.

Community Assistant, Department of Graduate Student Housing, Northwestern University, September 1997 – August 2000. Facilitated community-building, programmed educational and social events for residents, assisted in administrative duties, and helped residents during emergencies and crises.

GRANTS AND AWARDS

- Palmer Roberts Fellowship, Northwestern University, 2000-2001
- National Research Service Award, National Institute of Health, 1996-2000
- Institutional NIH Traineeship Grant, Northwestern University, 1995-1996
- Walter. P. Murphy Fellowship, Northwestern University, September 1994-1995

HONORS AND SOCIETIES

- Sarah Baskin Award for Excellence in Research, Rehabilitation Institute of Chicago, 1999
- Pi Tau Sigma, Mechanical Engineering National Honor Society, 93-94
- IEEE EMBS Society
- Society for Neuroscience

COMMITEES AND ADVISORY BOARDS

- Midwest region's Center for Medical Rehabilitation Research Advisory Board, National Institute of Health

EDITORIAL EXPERIENCE

- IEEE Transactions on Rehabilitation Engineering
- Journal of Neurophysiology
- Muscle & Nerve

PUBLICATIONS

J. M. Hidler, R.L. Harvey, B. D. Schmit, and W.Z. Rymer, "Characterization of muscle and tendon properties in spinal cord injured subjects using a modified Hill model." ***Annals of Biomedical Engineering***, In Preparation.

F. Popescu, J. M. Hidler, and W. Z. Rymer, " Elbow Impedance During Goal Directed Movements." ***Experimental Brain Research***, In Preparation.

J. M. Hidler, R.L. Harvey, and W.Z. Rymer, "Frequency response characteristics of ankle plantar flexors in humans following spinal cord injury: relation to degree of spasticity." ***Muscle & Nerve***, submitted, February 2001.

J. M. Hidler, R.L. Harvey, and W.Z. Rymer, "Muscle contractile dynamics in SCI: effects of spasticity level." ***NICHD/NCMRR Symposium***, Bethesda, MD, January, 2001.

J. M. Hidler and B. D. Schmit, "Evidence for increased force-feedback inhibition in chronic stroke." ***IEEE Transactions on Rehabilitation Engineering***, In review, Nov 2000.

J. M. Hidler and W. Z. Rymer, "Limit cycle behavior in spasticity: analysis and evaluation." ***IEEE Transactions on Biomedical Engineering***, vol. 47, pp. 1565-1575, December 2000.

F. Popescu, J. M. Hidler, and W. Z. Rymer, "Mechanical properties of the human joint during voluntary movement." ***The Society for the Neural Control of Movement***, April 2000.

J. M. Hidler and W. Z. Rymer, "Clonus in Spasticity: a stable limit cycle?" ***IEEE Engineering in Medicine and Biology Society***, July 2000.

J. M. Hidler and W. Z. Rymer, "Limit cycle behavior in spasticity, analysis and evaluation." ***National Center for Medical Rehabilitation Research Conference,*** December 1999.

J. M. Hidler and W. Z. Rymer, "A simulation study of reflex instability in spasticity: origins of clonus." ***IEEE Transactions on Rehabilitation Engineering***, vol. 7, pp. 327-340, September 1999.

J. M. Hidler, W. Z. Rymer, and J. P. Dewald, "Reflex instability in spasticity: origins of clonus." ***Society for Neuroscience Abstracts***, 1996.

SEMINARS AND INVITED PRESENTATIONS

- "Clonus in spastic subjects: a stable limit cycle?" IEEE Engineering in Medicine and Biology Society, Chicago, IL, July 2000.
- "Neuromuscular changes following spinal cord injury which lead to unstable reflex behavior." MIE 2000 Seminar Series, University of Massachusetts, Amherst, MA, April 2000.
- "Reflex Instability in Spasticity", Weekly Seminar Series, Sensory Motor Performance Program, Rehabilitation Institute of Chicago, May 1999.

REFERENCES

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